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THE INFLUENCE OF APPOINTMENT, PROMOTION, AND RETIREMENT POLICIES ON FACULTY RANK DISTRIBUTIONS

David S. P. Hopkins

Report No. 72-2

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ABSTRACT

The purpose of this paper is to demonstrate how certain personnel practices influence the ability of a university to achieve and maintain a desirable faculty rank distribution and new appointment rate when the faculty size is fixed. A mathematical model is formulated that relates faculty size, promotion rates, and tenure and nontenure lifetimes to the proportion in tenure and the annual appointment rate. Real data from the School of Humanities and Sciences at Stanford University is used to analyze the effects of several different appointment, promotion and retirement policies in that School. Equilibrium results are obtained to indicate what would happen if a given set of policies were followed for a long period of time and all behavioral parameters were to remain fixed. In addition, a short-run analysis is performed to investigate the extent to which an undesirable faculty rank distribution can be changed over the next ten years under altenative personnel policies.

I. INTRODUCTION

The purpose of this report is to demonstrate how certain personnel practices influence the size and rank composition of a university faculty. More specifically, we are interested in the question of how faculty appointment, promotion, and retirement policies bear on the ability of an educational institution to maintain the quality of its programs under severe budgetary restrictions. The seriousness of the problem is best illustrated by a specific example. During the ten-year period from 1959 to 1969 the number of professorial faculty members in the School of Humanities and Sciences at Stanford University increased at the average annual rate of 5.2% (Table 1); this expansion ended abruptly in 1969 when the administration decided that the total faculty size would have to remain fixed from that year forward. One obvious effect of this decision was to restrict the ability of the School to hire new faculty members in future years. To the extent that maintaining a steady influx of new people is important to the School's future well-being, therefore, it becomes necessary to understand how various practices can and do influence the number of vacancies that will become available to be filled during an annual cycle.

Table 1. School of Humanities and Sciences, Stanford University
Growth of Professorial Faculty in the Period 1959 to 1971

Academic Year	Assistant Professors*	Associate Professors	Professors	Total Professorial Faculty
1959-60	66	63	128	257
1960-61	76	66	135	277
1961-62	87	71	157	315
1962-63	79	73	161	313
1963-64	80	67	166	313
1964-65	87	66	178	331
1965-66	92	65	181	338
1966-67	106	69	193	368
1967-68	118	76	212	406
1968-69	116	75	212	403
1969-70	116	81	225	422
1970-71	120	70	234	424
1971-72	126	71	230	427

Source: School of Humanities and Sciences Faculty Rosters

* includes all Acting Assistant Professors

This problem is not unique to this School within this University. In fact, now that enrollments have ceased to grow and other sources of incremental income are no longer readily available, there is a tendency among a great many institutions of higher education to hold the line on faculty growth. By making explicit the relationships between important policy variables in a faculty personnel system, it is hoped that this paper will lead to a better understanding of the problems that generally arise in the "steady-state" and how these might be resolved.

II. A TWO-STATE MODEL OF FACULTY FLOWS

What exactly are the policies that, taken together, completely determine the composition of a faculty? Consider the simple "two-state" model of Figure 1 in which the left-hand block represents nontenure faculty, the right-hand block represents tenure faculty, the subscripted letters indicate variable stocks and flows, and the arrows indicate direction of flow.

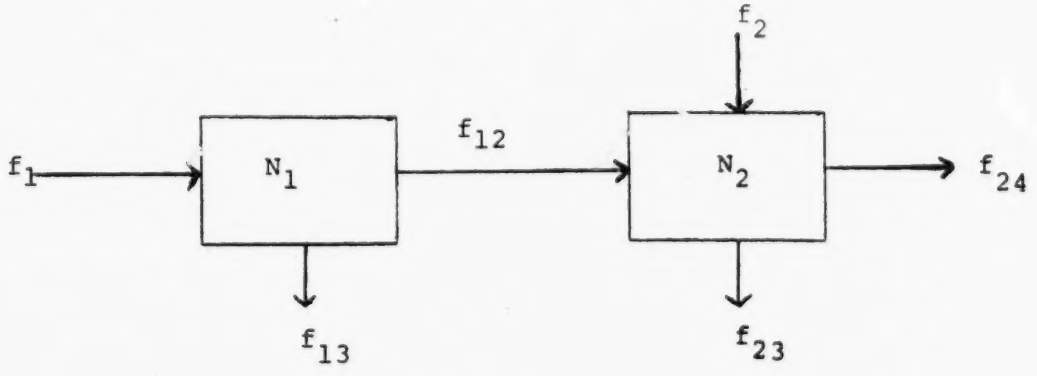


Figure 1. A Two-State Model of Faculty Flows

The variables of this model are defined as follows:

f_1 = new appointment rate to nontenure

f_2 = new appointment rate to tenure

f_{12} = promotion rate of nontenure faculty

f_{24} = retirement rate of tenure faculty

f_{13} = resignation and mortality rate from nontenure

f_{23} = resignation and mortality rate from tenure

N_1 = number of nontenure faculty

N_2 = number of tenure faculty.

Of these eight variables, all but the tenure resignation rate, f_{23}, are chiefly determined by institutional policy. However, not all of the remaining seven may be specified independently of each other. This is due to the existence of certain institutional restrictions that reduce the number of "degrees of freedom." These include a fixed faculty size and, when the system is in equilibrium, the requirement that the flow into each state exactly equal the flow out. Thus, there remain no more than four degrees of freedom, which is to say that the specification of any four of the variables f_1, f_2, f_{12}, f_{24}, f_{13}, f_{23}, N_1, and N_2 determines all of the others.

Suppose it is desired to increase the proportion of faculty in nontenure. There are essentially three policies that can achieve this result: (1) decreasing the promotion rate, f_{12};

(2) increasing the retirement rate, f_{24}; and (3) increasing the proportion of new appointments made to nontenure. We shall use the two-state model to examine the relative effects of such new operating policies.

Oliver [1969] used this model to identify feasible new appointment schedules for the Berkeley campus of the University of California under various policy restrictions. While our approach is similar to his, an important distinction is that in this paper we are concerned with both long-run and short-term effects, whereas he focussed exclusively on trade-offs in equilibrium.

1. Equilibrium Computations

For the purposes of this study, the following parameters are assumed to be known and given:

$\bar{N}$ = total faculty size

α_1 = fraction reappointed to nontenure

α_2 = fraction promoted to tenure after reappointment

β_1 = fraction of new appointments made to tenure

w_1' = lifetime in first stage of nontenure

w_1'' = lifetime in second stage of nontenure

w_2' = lifetime in tenure (promotions)

w_2'' = lifetime in tenure (new appointments).

The advancement of nontenure faculty proceeds in two successive stages. Initially, a new assistant professor is hired for a specified period of time. After this time has elapsed, a fraction α_1 receive a second appointment in nontenure; of these, α_2 are eventually promoted to tenure, while $(1 - \alpha_2)$ drop out of the system. A distinction is made in tenure lifetimes between those who are promoted from within and those who are initially appointed to tenure because members of the latter group are typically much older when they enter the system than are those of the former.

The first equation states that when the system is in equilibrium the flow into nontenure is balanced by the flow out:

$$f_1 = f_{12} + f_{13} \cdot \tag{1}$$

Equations (2) and (3) express the number of faculty in each group as the product of the average lifetime in the group and the flow rates of persons entering the group:

$$N_1 = (w_1' + \alpha_1 w_1'') f_1 \tag{2}$$

$$N_2 = w_2' f_{12} + w_2'' f_2 \cdot \tag{3}$$

The parameters α_1 and α_2 relate the flow rate of promotions to the flow rate of appointments to nontenure:

$$f_{12} = \alpha_1 \alpha_2 f_1 \quad , \tag{4}$$

while β relates the tenure new appointment rate to the total new appointment rate:

$$f_2 = \beta(f_1 + f_2) \quad . \tag{5}$$

Finally, Equation (6) expresses the quota restriction on the size of the faculty:

$$N_1 + N_2 = \bar{N} \quad . \tag{6}$$

Let $r \equiv N_2/(N_1 + N_2)$ be the proportion of faculty in tenure. Eqns. (1) through (6) may be solved for r in terms of known variables:

$$r = \left[\alpha_1\alpha_2 w_2' + \left(\frac{\beta}{1-\beta}\right) w_2''\right] \Big/ \left[w_1 + \alpha_1\alpha_2 w_2' + \left(\frac{\beta}{1-\beta}\right) w_2''\right], \tag{7}$$

where $w_1 \equiv w_1' + \alpha_1 w_1''$ is the average lifetime in nontenure. Similarly, we may solve for the total appointment rate:

$$f_1 + f_2 = [(1-\beta)w_1 + \alpha_1\alpha_2(1-\beta)\, w_2' + \beta w_2'']^{-1}\ \bar{N} . \tag{8}$$

Observe that the numerical value of the appointment rate depends on the faculty size, while the tenure proportion does not.

Equations (7) and (8) may be used to examine the trade-offs between promotion rates, rank distributions, and appointment rates under different operating policies. Figures 2 and 3 illustrate the long-run effects of three particular appointment and retirement policies, for specified promotion fractions.

Figure 2. Long-Run Fraction In Tenure Vs. Fraction Promoted From Nontenure Under Three Policy Alternatives

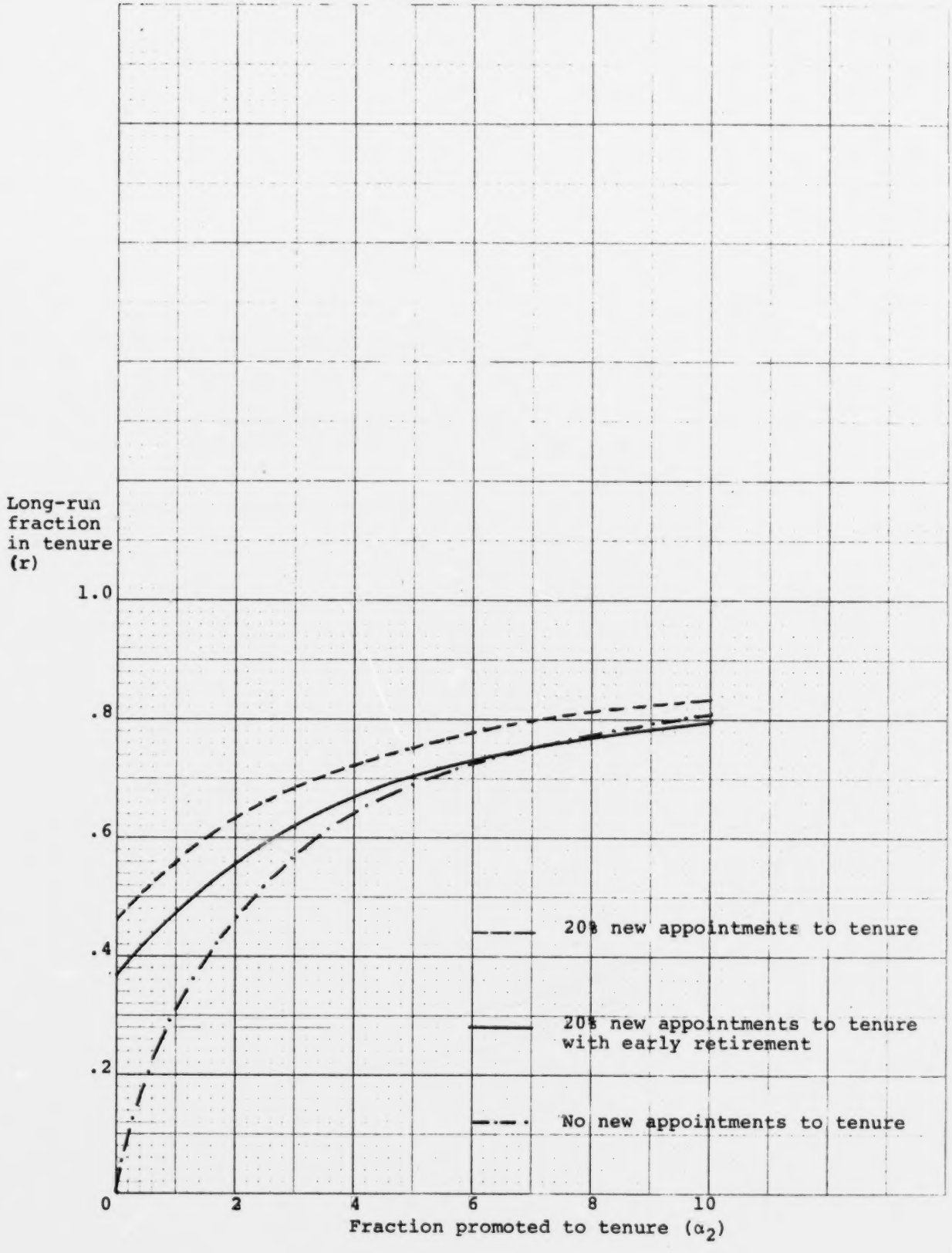
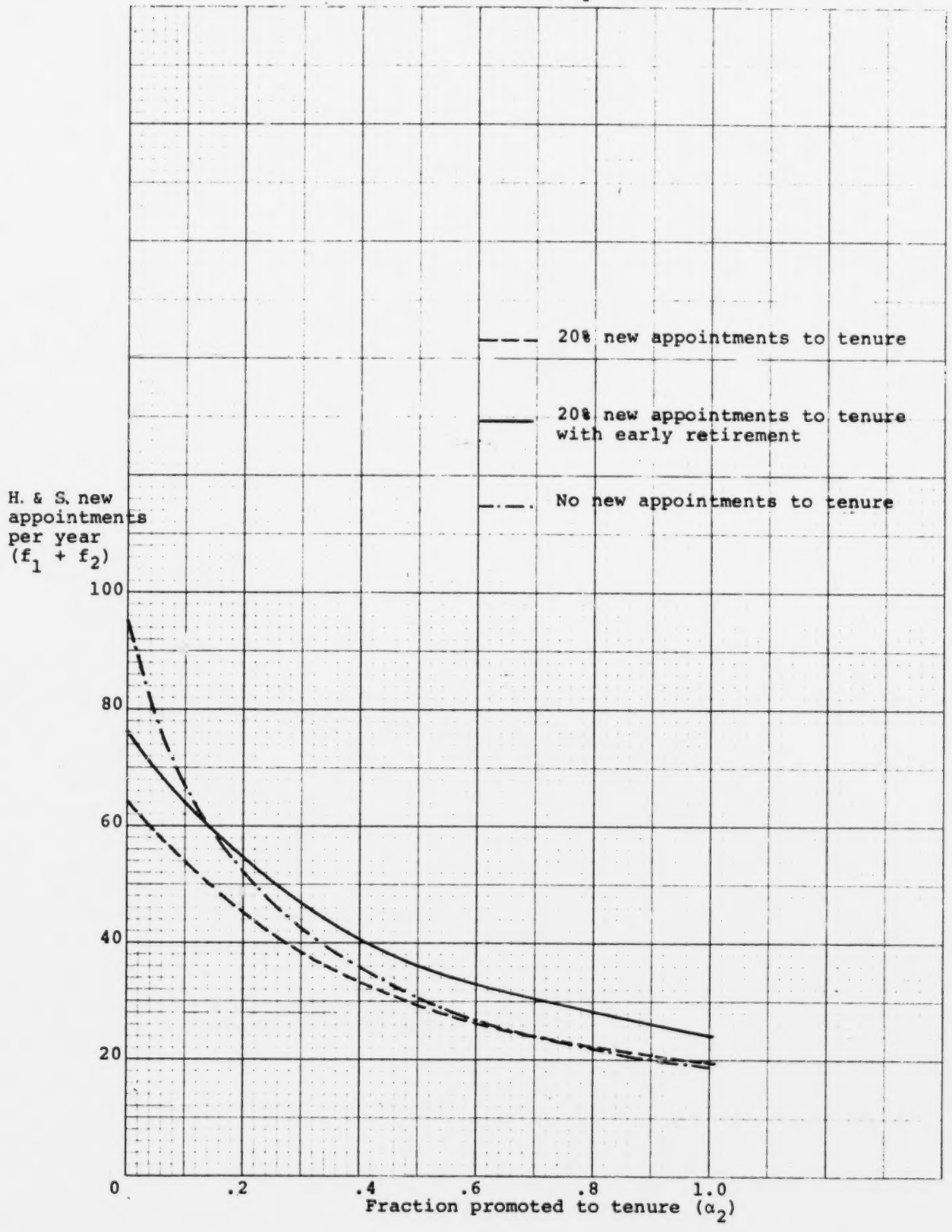


Figure 3. H. & S. New Appointments Vs. Fraction Promoted From Nontenure Under Three Policy Alternatives



Policy I (broken curve with alternating dots and dashes) assumes all vacancies are filled by nontenure appointees. Policy II (broken curve) is the case in which one in every five vacancies is filled by a tenure appointee. Policy III (solid curve) is the same as II, except that early retirement options are used to reduce tenure lifetimes by five years. Figure 2 shows the fraction in tenure that will eventually result from each of these policies while Figure 3 shows the corresponding annual appointment rate for the School of Humanities and Sciences at Stanford. The numerical values of parameters which were held fixed in these computations (see Table 2) were based as much as possible on data gathered from historical records

Table 2. Parameter Values Used in Equilibrium Compuations

Variable	Policy I	Policy II	Policy III
α_1	.75	.75	.75
β	0	.2	.2
w_1'	2.7	2.7	2.7
w_1''	2.2	2.2	2.2
w_2'	25	25	25
w_2''	15	15	15
$\bar{N}$	415	415	415

of the School. Specifically, the reappointment fraction and nontenure lifetimes were obtained from a cohort study of assistant professors who were first appointed in 1963-64 and 1964-65. The faculty size, $\bar{N}$, was fixed at the current level of regular faculty, not including assistant professors with Acting titles (see Table 3). Since data were not available for lifetimes in tenure, we used values that seemed reasonable and were consistent with observed rates of attrition over the past five years.

A most interesting feature of all the curves in Figures 2 and 3 is their initially steep slope. The result is that no matter what appointment policy is used, once the fraction of reappointed nontenure faculty members who are eventually promoted to tenure reaches 30% (corresponding to only 22% of those initially appointed), the tenure ratio will always exceed .55 and the new appointment rate will be below 50 per year. Beyond this point, the tenure ratio climbs more slowly to a maximum of around .8, the appointment rate drops more slowly to between 19 and 24, and the spread between the curves becomes insignificant.

The main consequence of the early retirement policy is to free up an additional 6 to 10 vacancies per year (Figure 3) which, for a given appointment and promotion policy, appears to reduce the tenure ratio by about .05 (Figure 2). Finally, it is interesting to note that in Figure 3 the curve for

Table 3. School of Humanities and Sciences
Actual Faculty Movements:
September 1, 1966 to September 1, 1971

Year	Nonten. Faculty*	Tenure Faculty	Promotions	Nontenure Terminations	Tenure Terminations			New Appts. Nontenure	New Appts. Tenure
					Resignations	Retirements	Deaths		
1966-67	105	252	8	8	5	2	2	21	16
1967-68	110	267	15	15	11	3	1	26	17
1968-69	106	284	11	11	7	4	0	32	15
1969-70	116	299	5	19	6	5	1	22	7
1970-71	114	299	7	12	8	6	3	25	7
1971-72	120	296							

Source: Humanities and Sciences Salary Rosters 1966-67 through 1971-72

* Does not include Acting Assistant Professors with short-term appointments.

Policy II actually crosses the curve for Policy I. This means that when the promotion rate is sufficiently high more vacancies will result when some new appointments are made directly to tenure, the reason being that such policies have the effect of reducing the average lifetime in the system.

2. Short-Run Effects

An equilibrium analysis serves to indicate the directions in which changes will occur due to new policies and, ultimately, the magnitude of these changes. For planning purposes, it is also important to predict the effects that will take place in the short run, for there is often a long lag (perhaps of the order of 20 to 25 years) between the time when a new policy is adopted and the time when the steady-state distribution and appointment rate shown in Figures 2 and 3 are actually achieved. Long tenure lifetimes make it difficult to change the faculty composition very significantly in the short run. To illustrate we shall perform a short-run analysis of certain of the policies discussed earlier.

While the equilibrium computations were based on a longitudinal model, short-run predictions were made using a cross-sectional model in which faculty stocks in year $t + 1$ depend only on faculty stocks in year t and new appointments made in the interval from t to $t + 1$. To be more explicit,

under a given set of policies we assume that each year some fraction p_{11} of the nontenure faculty remain in nontenure, a fraction p_{12} are promoted to tenure, and a fraction p_{22} of the tenure faculty remain in service. Thus, we may write, for $t = 0, 1, 2, \ldots$:

$$N_1(t+1) = p_{11}N_1(t) + f_1(t) \tag{9}$$

$$N_2(t+1) = p_{12}N_1(t) + p_{22}N_2(t) + f_2(t).$$

Equations (9) have as their steady-state analogs Equations (2) and (3); in the transient case, the p_{ij} are fractional flow rates, and the quantity $(1 - \sum_j p_{ij})N_i(t)$ is the rate of attrition from state i during year t. Constraints (5) and (6) are assumed to hold in each year, and so we have

$$f_2(t) = \beta[f_1(t) + f_2(t)] \quad , (t = 0, 1, \ldots) \text{ and} \tag{10}$$

$$N_1(t) + N_2(t) = \bar{N} \quad , (t = 1, 2, \ldots) . \tag{11}$$

If the system described by (9), (10), and (11) were in equilibrium, one could drop the time subscripts and solve for N_1 and f_{12} in terms of f_1; the result would be

$$N_1 = (1 - p_{11})^{-1} f_1 \quad \text{and} \tag{12}$$

$$f_{12} = p_{12} N_1 = p_{12} (1 - p_{11})^{-1} f_1 \ . \tag{13}$$

Making the correspondence between (12) and (2), and (13) and (4) enables us to express the cross-sectional fractions p_{11} and p_{12} in terms of longitudinal parameters:

$$p_{11} = 1 - (w_1' + \alpha_1 w_1'')^{-1} \tag{14}$$

$$p_{12} = \alpha_1\alpha_2(w_1' + \alpha_1 w_1'')^{-1} \quad . \tag{15}$$

In making short-run predictions (say extending 10 years in the future) it is meaningful to let policies affecting promotion fractions and nontenure lifetimes change the transition fractions p_{ij} according to (14) and (15) because these lifetimes are relatively short (say 3 to 5 years). The same cannot be said of the fraction p_{22}; since tenure lifetimes are long, in most applications p_{22} must be taken as a fixed datum in the short run.

For our short-run calculations, we specified values for $N_1(0)$, $N_2(0)$, $\bar{N}$, p_{22}, α_1, α_2, w_1', w_2'', and β. Equations (14) and (15) were used to compute p_{11} and p_{12}, and then Equations (9), (10), and (11) were solved iteratively for the $N_1(t)$, $N_2(t)$, $y_1(t)$, and $y_2(t)$. Values for the initial faculty stocks and the transition fraction p_{22} were based on a study of actual faculty flows in the School of Humanities and Sciences during the period September 1966 to September 1971. The results of that study are summarized in Tables 3 and 4.

Table 4. School of Humanities and Sciences
Fractional Flow Rates of Faculty:
September 1, 1966 to September 1, 1971

	Nontenure		Tenure		
Year	Promotion Rate	Termination Rate	Resignation Rate	Retirement Rate	Death Rate
1966-67	8%	8%	2.0%	0.8%	0.8%
1967-68	14%	14%	4.1%	1.1%	0.4%
1968-69	10%	10%	2.5%	1.4%	0
1969-70	4%	16%	2.0%	1.7%	0.3%
1970-71	6%	11%	2.7%	2.0%	1.0%
Five-Year Average	8%	12%	2.7%	1.4%	0.5%

Predictions were made for four of the policies discussed earlier. Table 5 shows the parameter values used in these computations; the results, expressed as faculty stocks and flows during the ten-year period beginning with the current academic year, are shown in Tables 6 through 9.

Table 5. Parameter Values for Short-Run Computations

Variable	Policy A	Policy B	Policy C	Policy D
$N_1(0)$	120	120	120	120
$N_2(0)$	296	296	296	296
$\bar{N}$	415	415	415	415
β	0	0	.2	.2
α_1	.75	.75	.75	.75
α_2	0	.3	.3	.3
w_1'	2.7	2.7	2.7	2.7
w_2''	2.2	2.2	2.2	2.2
p_{22}	.945	.945	.945	.92

(Note: The value .945 for p_{22} in Table 5 is based on a resignation rate of 2.5%, a retirement rate of 2.5%, and a mortality rate of 0.5%.)

Table 6. Short-Run Changes in Humanities & Sciences Faculty Composition

Policy A: NO NEW APPOINTMENTS TO TENURE
NO PROMOTIONS FROM NONTENURE

Year	Nontenure Faculty	Tenure Faculty	Tenure Proportion	Promotions	Nontenure Terminations	Tenure Terminations	New Appointments
1971-72	120	296	.71	0	28	16	44
1972-73	136	279	.67	0	31	15	46
1973-74	151	264	.64	0	35	15	50
1974-75	166	249	.60	0	38	14	52
1975-76	180	235	.57	0	41	13	54
1976-77	193	222	.53	0	44	12	56
1977-78	205	210	.51	0	47	12	59
1978-79	217	198	.48	0	50	11	61
1979-80	228	187	.45	0	52	10	62
1980-81	238	177	.43				

Table 7. Short-Run Changes in Humanities & Sciences Faculty Composition

Policy B: NO NEW APPOINTMENTS TO TENURE
30% PROMOTIONS FROM NONTENURE

Year	Nontenure Faculty	Tenure Faculty	Tenure Proportion	Promotions	Nontenure Terminations	Tenure Terminations	New Appointments
1971-72	120	296	.71	6	21	16	37
1972-73	130	285	.69	7	23	16	39
1973-74	139	276	.67	7	25	15	40
1974-75	147	268	.65	8	26	15	41
1975-76	154	261	.63	8	27	14	41
1976-77	160	255	.61	8	29	14	43
1977-78	166	249	.60	9	30	14	44
1978-79	171	244	.59	9	30	13	43
1979-80	175	240	.58	9	31	13	44
1980-81	179	236	.57				

Table 8. Short-Run Changes in Humanities & Sciences Faculty Composition

Policy C: 20% NEW APPOINTMENTS TO TENURE
30% PROMOTIONS FROM NONTENURE

Year	Nontenure Faculty	Tenure Faculty	Tenure Proportion	Promotions	Nontenure Terminations	Tenure Terminations	New Appointments
1971-72	120	296	.71	6	21	16	37
1972-73	123	292	.70	6	22	16	38
1973-74	125	290	.70	6	22	16	38
1974-75	127	288	.69	7	23	16	39
1975-76	128	287	.69	7	23	16	39
1976-77	129	286	.69	7	23	16	39
1977-78	130	285	.69	7	23	16	39
1978-79	131	284	.68	7	23	16	39
1979-80	132	283	.68	7	24	16	40
1980-81	133	282	.68				

Table 9. Short-Run Changes in Humanities & Sciences Faculty Composition

Policy D: 20% NEW APPOINTMENTS TO TENURE
30% PROMOTIONS FROM NONTENURE
EARLY RETIREMENT

Year	Nontenure Faculty	Tenure Faculty	Tenure Proportion	Promotions	Nontenure Terminations	Tenure Terminations	New Appointments
1971-72	120	296	.71	6	21	24	45
1972-73	129	286	.69	7	23	23	46
1973-74	136	279	.67	7	24	22	46
1974-75	142	273	.66	7	25	22	47
1975-76	148	267	.64	8	26	21	47
1976-77	152	263	.63	8	27	21	48
1977-78	155	260	.63	8	28	21	49
1978-79	158	257	.62	8	28	21	49
1979-80	161	254	.61	8	29	20	49
1980-81	163	252	.61				

Policy A represents the extreme case in which no nontenure faculty are promoted to tenure and no new faculty are appointed to tenure. Here, all vacancies created by attrition from tenure result in additions to nontenure. This policy leads to a steady decrease in the tenure proportion from .71 to .43 in ten years, and to a steady increase in new appointments from 44 to 65.

In Policy B it is assumed that 30 per cent of all reappointed nontenure faculty are eventually promoted to tenure. There are still no appointments directly to tenure. As one would expect, in comparison with the no-promotion policy the decrease in the tenure ratio and the increase in the new appointment rate occur at a much slower rate. However, the tenure ratio has still been brought down below .6 by the end of the ten-year period.

Policy C assumes a promotion fraction of .3 and, in addition, a tenure appointment fraction of .2 . Such a policy comes very close to maintaining the status quo. At the end of ten years the tenure proportion is reduced by only .03, and the appointment rate is increased by only three new faculty members per year.

Policy D superimposes an early retirement program on the calculations for Policy C. Early retirements are assumed to cause the fractional retirement rate to double from 2.5% to 5% per year. As a result, it is apparent from Table 9 that even

when appointment and promotion rates are increased the tenure proportion can still be reduced by .1 over the short run. Of course, a faster reduction in the tenure ratio could be achieved if the early retirement program were coupled with efforts to reduce promotion rates even further and to substitute more nontenure appointments for tenure appointments when vacant positions are being filled.

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